Ph.D. Thesis Abstract

Urban Structure Extraction Using Soft Computing Techniques

The phenomenon of rapid urban development has been an extremely challenging issue. India has seen an unprecedented growth of cities in the past three decades with the evolution of a series of megacities and urban conurbations. The administration requires updated information on the existing inventories to estimate the gaps and assess required investments. For instance, projects related to utility planning, renewable energy assessment, taxation or 3D cadaster, positioning and planning of telecommunication towers, emergency response systems, disaster management, and many such investments will require detailed and updated datasets of existing infrastructure. The role of geospatial datasets in large infrastructure projects has been highlighted at a number of forums, including the United Nations vision document for sustainable development goals. With the advancement in high-performance computing and remote sensing imagery data sources, the development of intelligent models for the automated extraction of information on critical infrastructure is conceivable. Thus, the thesis aimed at developing a pipeline that can automatically capture spatial features from complex urban scenarios using remote sensing imagery data and deep learning algorithms. The urban features of interest include building footprints with information on height and roof area. The approach requires the development of two critical methods. The first model is for extracting building footprints from high-resolution multispectral imagery, and the second would estimate heights from high-resolution stereo imagery. The data preparation for the extraction of building footprints in the study comprises procurement of remote sensing images, pan sharpening, preparation of true-color composite and labelling the building outlines. Additionally, building heights from ground-based measurements are used for the evaluation of the model estimations.

Deep learning algorithms have achieved significant accuracy in remote sensing image segmentation. However, the generation of map-ready spatial data that meets essential accuracy standards using existing methods remains uncertain. The deep learning model should be able to generate polygonal outlines from the remote sensing image for building extraction. The scope of the currently trained model is limited to images from specific satellite sensors. Additionally, approaches for visualization of 3D building block models using interactive tools are demonstrated. The visualization of 3D buildings on a map environment draws the audience's immediate attention due to its realistic experience. Furthermore, an application use case of rooftop solar photovoltaic potential estimations of a city is demonstrated. The proposed work is addressing automated data generation that has implications across verticals of geospatial applications. The project aims to assist decision-makers in formulating upcoming policies based on sound information and accelerate the process of dataset creation. It guarantees the flexibility of the timely availability of map-based information and empowers authorities to make informed decisions. The project will further help in advancing the shift towards digital transformation in a most prolific manner.

Keywords: *Geospatial technology, satellite images, remote sensing, deep learning, building extraction, height estimation, 3D mapping, solar potential*

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